

U.S. ARMY CORPS OF ENGINEERS
Kansas City District

KANSAS CITYS, MISSOURI AND KANSAS
FLOOD DAMAGE REDUCTION
FEASIBILITY STUDY

**ENGINEERING APPENDIX TO THE
INTERIM FEASIBILITY REPORT**

August, 2006

ENGINEERING APPENDIX A

Kansas Citys, Missouri and Kansas

Flood Damage Reduction Project Feasibility Study

TABLE OF CONTENTS

A-2.4.4	Traditional Analysis vs. Risk Based Analysis	2-6
A-2.4.5	Hydrologic Uncertainty.....	2-7
A-2.5	Hydraulics.....	2-7
A-2.5.1	HEC-RAS Model Development	2-7
A-2.5.2	River System Schematic and Cross-Section Data.....	2-7
A-2.5.3	Bridge Data.....	2-8
A-2.5.4	Other Geometric Data.....	2-10
A-2.5.5	1993 Flow Data.....	2-10
A-2.5.6	Calibration.....	2-11
A-2.6	Existing Conditions	2-13
A-2.6.1	Missouri River Water Surface Profiles.....	2-13
A-2.6.2	Kansas River Water Surface Profiles.....	2-15
A-2.6.3	Hydraulic Uncertainty.....	2-17
A-2.7	Levee Tieback Analysis.....	2-18
A-2.7.1	Introduction.....	2-18
A-2.7.2	Birmingham Levee Unit.....	2-19
A-2.7.3	East Bottoms Levee Unit.....	2-20
A-2.7.4	North Kansas City Levee Unit.....	2-21
A-2.8	Interior Floodwater/Exterior Water Surface Relationships	2-22
A-2.8.1	Introduction.....	2-22
A-2.8.2	Approach	2-22
A-2.8.3	Results.....	2-23
A-2.9	Interior Stormwater Flooding Evaluation	2-24
A-2.9.1	Introduction.....	2-24
A-2.9.2	Drainage Control Structure Preliminary Screening.....	2-24
A-2.9.3	Hydrologic and Hydraulic Analysis.....	2-25
A-2.9.4	Flood Inundation Mapping	2-26
A-2.9.5	Critical Drainage Control Structure Screening.....	2-26
A-2.10	Bridge Hydraulic Impact Analysis	2-27
A-2.11	Future Conditions Without Project (Baseline)	2-28
A-2.11.1	Future Changes to Missouri River Model.....	2-29
A-2.11.2	Future Changes to Kansas River Model	2-30
A-2.11.3	Future Conditions Water Surface Profiles.....	2-31
A-2.11.4	Hydraulic Uncertainty	2-32
A-2.12	Interim Feasibility – Future Conditions with Project	2-32
A-2.12.1	Argentine Unit Levee Raise.....	2-33
A-2.12.2	Seepage Controls, Missouri and Blue Rivers Confluence Area, East Bottoms Unit.....	2-33
A-2.12.3	Rehabilitation/Improvement of Floodwall, Fairfax-Jersey Creek Unit	2-35
A-2.12.4	Rehabilitation/Improvement of Sheetpile Wall, Fairfax-Jersey Creek Unit	2-35
A-2.12.5	Seepage Controls, Harlem Area, North Kansas City Unit.....	2-35
A-2.12.6	Seepage Controls, National Starch Area, North Kansas City Unit.....	2-35

A-2.12.7	Kansas River Tree Removal	2-35
A-2.12.8	Kansas River Tree Removal and Channel Modification	2-36
A-2.13	References.....	2-38
A-2.14	Supplemental Exhibits	2-40
A-3	SURVEYING, MAPPING, AND OTHER GEOSPATIAL DATA REQUIREMENTS	
A-3.1	Information to Support Preparation of Feasibility Report	3-1
	A-3.1.1 Surveys	3-1
	A-3.1.2 Geospatial Data.....	3-2
A-3.2	Survey Information Needed for Design, Plans, and Specs	3-4
A-3.3	Supplemental Exhibits	3-5
A-4	GEOTECHNICAL ANALYSIS – EXISTING CONDITIONS	
A-4.1	Introduction.....	4-1
A-4.2	Sources of Information	4-1
A-4.3	Description of Levee Units.....	4-1
	A-4.3.1 Argentine Unit.....	4-1
	A-4.3.2 Armourdale Unit.....	4-1
	A-4.3.3 Birmingham Unit.....	4-2
	A-4.3.4 Central Industrial District - Kansas Unit (CID-KS)	4-2
	A-4.3.5 Central Industrial District - Missouri Unit (CID-MO) ..	4-3
	A-4.3.6 East Bottoms Unit.....	4-3
	A-4.3.7 Fairfax-Jersey Creek Unit.....	4-4
	A-4.3.8 North Kansas City - Airport Unit	4-4
	A-4.3.9 North Kansas City - Lower Unit.....	4-4
A-4.4	Site Conditions.....	4-4
	A-4.4.1 General Geology of the Region (Missouri River).....	4-4
	A-4.4.2 General Geology of the Region (Kansas River).....	4-5
	A-4.4.3 Subsurface Conditions.....	4-5
A-4.5	Levee Design Features.....	4-5
	A-4.5.1 Basic Levee Sections	4-5
	A-4.5.2 Seepage Control Measures.....	4-6
	A-4.5.3 Stability Berms.....	4-6
A-4.6	Assessment of Levee Integrity.....	4-6
A-4.7	Probabilistic Theory.....	4-7
	A-4.7.1 Probabilistic Parameters	4-7
	A-4.7.2 Probabilistic Distributions.....	4-8
	A-4.7.3 Probabilistic Measure of Stability for Slopes.....	4-9
	A-4.7.4 Probabilistic Measure of Stability for Underseepage Using Flow Nets	4-10
	A-4.7.5 Probabilistic Measure of Stability for Underseepage Without Flow Nets	4-10
	A-4.7.6 Taylor Series Approximation Method for Determining Risk and Uncertainty Analysis.....	4-11

A-4.8	Uncertainty Analyses.....	4-13
A-4.8.1	General.....	4-13
A-4.8.2	Soil Properties and Variations.....	4-14
A-4.8.3	Probabilistic Underseepage Analysis Using a Flow Net.....	4-16
A-4.8.4	Probabilistic Underseepage Analysis Using the Kansas City District Criteria.....	4-17
A-4.8.5	Probabilistic Slope Stability Analysis	4-18
A-4.8.6	Combined Probability of Failure Due to the Slope Stability and Underseepage.....	4-20
A-4.9	Results for the Risk-Based Analyses of the Kansas City – Missouri and Kansas Flood Protection Project	4-20
A-4.9.1	Argentine Levee Unit Results.....	4-20
A-4.9.2	Armourdale Levee Unit Results.....	4-21
A-4.9.3	Birmingham Levee Unit Results	4-21
A-4.9.4	Central Industrial District-Kansas (CID-KS) Levee Unit Results.....	4-21
A-4.9.5	Central Industrial District-Missouri (CID-MO) Levee Unit Results	4-22
A-4.9.6	East Bottoms Levee Unit Results	4-22
A-4.9.7	Fairfax-Jersey Creek Unit Results	4-23
A-4.9.8	North Kansas City (Airport and Lower)Levee Unit Results.....	4-23
A-4.10	Summary.....	4-24
A-4.11	References.....	4-25
A-4.12	Supplemental Exhibits and Tables.....	4-28
A-5	GEOTECHNICAL ANALYSIS – ARGENTINE RAISE	
A-5.1	Introduction.....	5-1
A-5.2	Sources of Information	5-1
A-5.3	Description of the Levee Unit.....	5-1
A-5.4	Site Conditions.....	5-1
A-5.4.1	General Geology of the Region (Kansas River)	5-1
A-5.4.2	Subsurface Conditions.....	5-1
A-5.5	Basic Existing Levee Sections.....	5-2
A-5.6	Underseepage Anaylsis.....	5-3
A-5.7	Stability Analysis.....	5-9
A-5.7.1	Nominal 500-Year Raise	5-9
A-5.7.2	Nominal 500-Year Raise Plus 3 Feet.....	5-10
A-5.7.3	Nominal 500-Year Raise Plus 5 Feet.....	5-10
A-5.8	Relief Wells	5-14
A-5.9	Recommended Plan	5-14
A-5.10	References.....	5-15
A-5.11	Supplemental Exhibits	5-18

A-6	GEOTECHNICAL ANALYSIS - EAST BOTTOMS (MISSOURI AND BLUE RIVERS CONFLUENCE AREA)	
A-6.1	Introduction.....	6-1
A-6.2	Sources of Existing Levee Design Information.....	6-1
A-6.3	Description of the Levee Unit.....	6-1
A-6.4	Levee Design Features.....	6-1
	A-6.4.1 Basic Existing Levee and Floodwall Sections.....	6-1
	A-6.4.2 Future Flood Protection Concerns.....	6-1
	A-6.4.3 Area Site Characterization.....	6-2
	A-6.4.4 Underseepage Analyses.....	6-2
A-6.5	References.....	6-6
A-6.6	Supplemental Exhibits	6-8
A-7	GEOTECHNICAL ANALYSIS – FAIRFAX-JERSEY CREEK (BPU FLOODWALL)	
A-7.1	Introduction.....	7-1
A-7.2	Sources of Existing Levee Design Information.....	7-1
A-7.3	Description of the Levee Unit.....	7-1
A-7.4	Levee Design Features.....	7-1
	A-7.4.1 Existing Levee and Floodwall Sections.....	7-1
	A-7.4.2 Future Flood Protection Concerns.....	7-1
	A-7.4.3 Area Site Characterization.....	7-1
	A-7.4.4 Pile Capacity.....	7-2
	A-7.4.5 Underseepage Analysis.....	7-2
A-7.5	References.....	7-3
A-7.6	Supplemental Exhibits	7-5
A-8	GEOTECHNICAL ANALYSIS – FAIRFAX-JERSEY CREEK (JERSEY CREEK SHEET PILE WALL)	
A-8.1	Introduction.....	8-1
A-8.2	Sources of Existing Levee Design Information.....	8-1
A-8.3	Description of the Levee Unit.....	8-1
A-8.4	Levee Design Features.....	8-1
	A-8.4.1 Basic Existing Levee and Floodwall Sections.....	8-1
	A-8.4.2 Future Flood Protection Concerns.....	8-1
	A-8.4.3 Area Site Characterization.....	8-2
A-8.5	Analysis Model for Risk and Uncertainty	8-4
	A-8.5.1 River Bed Scour Determination.....	8-4
	A-8.5.2 Loss of Sheet Pile Wall.....	8-6
	A-8.5.3 First Loss of Foreshore Bank.....	8-7
	A-8.5.4 Secondary Loss of Foreshore Bank Including Levee with I-Wall Flood Protection	8-9
	A-8.5.5 Resulting Reliability of the Existing Cross Section Station 27+50	8-10
A-8.6	Recommended Course of Action.....	8-11
A-8.7	References.....	8-13

A-8.6 Supplemental Exhibits	8-14
A-9 GEOTECHNICAL ANALYSIS – NORTH KANSAS CITY - LOWER (HARLEM AREA)	
A-9.1 Introduction.....	9-1
A-9.2 Sources of Existing Levee Design Information.....	9-1
A-9.3 Description of the Levee Unit.....	9-1
A-9.4 Levee Design Features.....	9-1
A-9.4.1 Existing Levee and Floodwall Sections.....	9-1
A-9.4.2 Future Flood Protection Concerns.....	9-2
A-9.4.3 Area Site Characterization.....	9-2
A-9.4.4 Underseepage Analyses.....	9-2
A-9.4.5 Reassessment of Existing Risk and Uncertainty.....	9-5
A-9.5 References.....	9-7
A-9.6 Supplemental Exhibits	9-9
A-10 GEOTECHNICAL ANALYSIS – NORTH KANSAS CITY – LOWER (NATIONAL STARCH AREA)	
A-10.1 Introduction.....	10-1
A-10.2 Sources of Existing Levee Design Information.....	10-1
A-10.3 Description of the Levee Units	10-1
A-10.4 Levee Design Features.....	10-1
A-10.4.1 Existing Levee and Floodwall Sections.....	10-1
A-10.4.2 Future Flood Protection Concerns.....	10-2
A-10.4.3 Area Site Characterization.....	10-2
A-10.4.4 Underseepage Analysis.....	10-3
A-10.4.5 Proposed Future Conditions Assessment.....	10-5
A-10.4.6 Reassessment of Existing Risk and Uncertainty.....	10-6
A-10.5 References.....	10-8
A-10.6 Supplemental Exhibits	10-10
A-11 CIVIL DESIGN	
A-11.1 Site Selection and Project Development (Argentine Unit).....	11-1
A-11.1.1 Introduction.....	11-1
A-11.1.2 Levee Footprint.....	11-1
A-11.1.3 Bridge Clearances	11-2
A-11.2 Real Estate (Argentine Unit)	11-2
A-11.3 Utility Relocations (Argentine Unit)	11-2
A-11.3.1 Utility Levee Crossings	11-3
A-11.3.2 Power Lines.....	11-5
A-11.3.3 Utility Uplift	11-5
A-11.4 East Bottoms Unit (Missouri and Blue Rivers Confluence Area	11-6
A-11.5 Fairfax-Jersey Creek Unit (BPU Floodwall)	11-6
A-11.6 North Kansas City-Lower Unit (Harlem Area)	11-9
A-11.6.1 Introduction.....	11-9

A-11.6.2	Levee Footprint.....	11-9
A-11.6.3	Proposed Levee Modifications (Buried Collector System).....	11-9
A-11.6.4	Utility Relocations and Coordination.....	11-9
A-11.7	North Kansas City-Lower Unit (National Starch Area)	11-10
A-11.7.1	Introduction.....	11-10
A-11.7.2	Levee Footprint.....	11-11
A-11.7.3	Proposed Modifications (Relief Well System Header and Pump Station)	11-11
A-11.7.4	Utility Relocations and Coordination.....	11-13
A-11.8	References.....	11-15
A-11.9	Supplemental Exhibits	11-16
A-12	STRUCTURAL ANALYSIS – EXISTING CONDITIONS	
A-12.1	Introduction.....	12-1
A-12.2	Description of Levee Units – Structural Aspects	12-1
A-12.2.1	Argentine Unit.....	12-1
A-12.2.2	Armourdale Unit.....	12-1
A-12.2.3	Birmingham Unit.....	12-2
A-12.2.4	Central Industrial District-Kansas Unit	12-2
A-12.2.5	Central Industrial District-Missouri Unit.....	12-3
A-12.2.6	East Bottoms Unit.....	12-3
A-12.2.7	Fairfax-Jersey Creek Unit.....	12-3
A-12.2.8	North Kansas City-Airport Unit	12-4
A-12.2.9	North Kansas City-Lower Unit.....	12-4
A-12.3	Floodwall Analysis	12-4
A-12.3.1	General.....	12-4
A-12.3.2	Methodology.....	12-5
A-12.3.3	Data Gathering.....	12-5
A-12.3.4	Floodwalls on Spread Footing	12-5
A-12.3.5	Floodwalls on Piles.....	12-6
A-12.3.6	Floodwalls on Concrete Capped Sheet Piling	12-7
A-12.3.7	Results.....	12-7
A-12.4	Retaining Wall Analysis.....	12-8
A-12.5	Closure Structures.....	12-8
A-12.6	Summary.....	12-9
A-12.7	Existing Conditions Addendum to Argentine Analysis.....	12-9
A-12.7.1	Criteria	12-10
A-12.7.2	Floodwalls.....	12-12
A-12.7.3	Stop Log Gaps	12-13
A-12.7.4	Gatewells.....	12-13
A-12.7.5	Reinforced Concrete Box Culverts.....	12-14
A-12.8	Supplemental Exhibits	12-18

A-13 STRUCTURAL ANALYSIS – ARGENTINE RAISE	
A-13.1 Introduction.....	13-1
A-13.2 Criteria	13-1
A-13.2.1 Stability Requirements.....	13-1
A-13.2.2 Strength Requirements.....	13-2
A-13.2.3 Uncertainty Analysis	13-2
A-13.3 Argentine Unit	13-4
A-13.3.1 Description of the Levee Unit – Structural.....	13-4
A-13.3.2 Assumptions	13-4
A-13.3.3 Floodwalls.....	13-4
A-13.3.4 Stop Log Gaps	13-6
A-13.3.5 Gatewells and Outlets.....	13-7
A-13.3.6 I-Wall.....	13-8
A-13.3.7 Reinforced Concrete Box Culverts.....	13-10
A-13.4 References.....	13-12
A-14 STRUCTURAL ANALYSIS – FAIRFAX-JERSEY CREEK (BPU FLOODWALL)	
A-14.1 Introduction.....	14-1
A-14.2 Criteria	14-1
A-14.2.1 Capacity Requirements.....	14-1
A-14.2.2 Strength Requirements.....	14-1
A-14.2.3 Uncertainty Analysis	14-2
A-14.3 Fairfax-Jersey Creek Unit.....	14-3
A-14.3.1 Description of the Fairfax-Jersey Creek Unit – Structures	14-3
A-14.3.2 Assumptions	14-3
A-14.3.3 Floodwall 287+86 to 302+32.....	14-3
A-14.3.4 Floodwall Modifications 287+86 to 302+32	14-6
A-14.3.5 Stop Log Gap.....	14-7
A-14.3.6 Controlling Mechanism	14-7
A-14.4 References.....	14-9
A-14.5 Supplemental Exhibits	14-10
A-15 ARGENTINE UNIT PUMP STATION ANALYSIS	
A-15.1 Summary.....	15-1
A-15.1.1 Sources of Information	15-1
A-15.1.2 Recommendations.....	15-1
A-15.1.3 Information Used in the Economic Model	15-3
A-15.1.4 Summary Table of Pump Station Modifications	15-4
A-15.2 Federal Pump Station Modifications	15-5
A-15.2.1 Background.....	15-5
A-15.2.2 Existing and Future Conditions Evaluation.....	15-6
A-15.2.3 Alternatives Evaluation	15-18
A-15.2.4 Recommended Alternatives Summary	15-22
A-15.3 Private Pump Station Modifications	15-24

A-15.3.1	Bulk Mail Pump Station	15-24
A-15.3.2	ConAgra Pump Station	15-25
A-15.3.3	Santa Fe Pump Station.....	15-26
A-15.4	Supplemental Exhibits	15-28
A-16	COST ENGINEERING	
A-16.1	Total Project Cost Summaries	16-1
A-16.2	Argentine Raise	16-9
A-16.3	East Bottoms (Hawthorn Pump Plant Area).....	16-61
A-16.4	Fairfax-Jersey Creek (BPU Floodwall)	16-75
A-16.5	Fairfax-Jersey Creek (Jersey Creek Sheetpile Wall)	16-100
A-16.6	North Kansas City-Lower (Harlem Area)	16-115
A-16.7	North Kansas City-Lower (National Search Area).....	16-129
A-17	CONSTRUCTION PROCEDURES AND WATER CONTROL PLAN	
A-17.1	Introduction.....	17-1
A-17.2	Argentine Raise	17-1
A-17.2.1	Site Constraints.....	17-1
A-17.2.2	Material Sources	17-2
A-17.2.3	Construction Procedures.....	17-2
A-17.2.4	Water Control	17-4
A-17.3	East Bottoms (Missouri and Blue Rivers Confluence Area)....	17-5
A-17.3.1	Site Constraints.....	17-5
A-17.3.2	Material Sources	17-5
A-17.3.3	Construction Procedures.....	17-5
A-17.3.4	Water Control	17-5
A-17.4	Fairfax-Jersey Creek (BPU Floodwall)	17-5
A-17.4.1	Site Constraints.....	17-6
A-17.4.2	Material Sources	17-6
A-17.4.3	Construction Procedures.....	17-6
A-17.4.4	Water Control	17-6
A-17.5	Fairfax-Jersey Creek (Jersey Creek Sheetpile Wall)	17-7
A-17.5.1	Site Constraints.....	17-7
A-17.5.2	Material Sources	17-7
A-17.5.3	Construction Procedures.....	17-7
A-17.5.4	Water Control	17-7
A-17.6	North Kansas City-Lower (Harlem Area)	17-7
A-17.6.1	Site Constraints.....	17-7
A-17.6.2	Material Sources	17-8
A-17.6.3	Construction Procedures.....	17-8
A-17.6.4	Water Control	17-8
A-17.7	North Kansas City-Lower (National Starch Area)	17-8
A-17.7.1	Site Constraints.....	17-8
A-17.7.2	Material Sources	17-8
A-17.7.3	Construction Procedures.....	17-8
A-17.7.4	Water Control	17-9

A-18	ACCESS ROADS.....	18-1
A-18.1	Argentine Raise	18-1
A-18.2	East Bottoms (Missouri and Blue Rivers Confluence Area)	18-4
A-18.3	Fairfax-Jersey Creek (BPU Floodwall)	18-6
A-18.4	Fairfax-Jersey Creek (Jersey Creek Sheetpile Wall)	18-8
A-18.5	North Kansas City-Lower (Harlem Area)	18-10
A-18.6	North Kansas City-Lower (National Starch Area)	18-12
A-19	SCHEDULE FOR DESIGN AND CONSTRUCTION	
A-19.1	Scheduling	19-1

INDEX TO ENGINEERING APPENDIX PLATES

Plate A-1.1 Location and Vicinity of Kansas Citys Flood Protection Project.....	1-6
Plate A-1.2 Argentine Footprint Mapping (1 of 5).....	1-10
Plate A-1.3 Argentine Footprint Mapping (2 of 5).....	1-11
Plate A-1.4 Argentine Footprint Mapping (3 of 5).....	1-12
Plate A-1.5 Argentine Footprint Mapping (4 of 5).....	1-13
Plate A-1.6 Argentine Footprint Mapping (5 of 5).....	1-14
Plate A-1.7 East Bottoms (Missouri and Blue Rivers Confluence Area) Footprint Mapping	1-15
Plate A-1.8 Fairfax-Jersey Creek (BPU Floodwall) Footprint Mapping.....	1-16
Plate A-1.9 Fairfax-Jersey Creek (Jersey Creek Sheet Pile Wall) Footprint Mapping.....	1-17
Plate A-1.10 NKC-Lower (Harlem Area) Footprint Mapping	1-18
Plate A-1.11 NKC-Lower (National Starch Area) Footprint Mapping	1-19

INDEX TO ENGINEERING APPENDIX TABLES

Table A-2.1 Ten Largest Floods on the Missouri River in the Vicinity of the Kansas Citys Study Area 1897-1997.....	2-2
Table A-2.2 Kansas City Metropolitan Area Levees Design and Coincident Discharges - Missouri and Kansas Rivers.....	2-3
Table A-2.3 Discharges Used to Design Kansas River Kansas City Metropolitan Area Levees.....	2-4
Table A-2.4 Flow Frequency from March 1962 Hydrology Report.....	2-4
Table A-2.5 Flow Frequency Data as Developed in Upper Mississippi River System Flow Frequency Study and Kansas River Hydrology Report.....	2-5
Table A-2.6 Summary of Flood Discharges Used in this Study.....	2-6
Table A-2.7 Kansas River Bridges Critical Low Chord Elevations.....	2-9
Table A-2.8 Comparison of 1993 High-Water Mark Elevations and Computed Water Surface Elevations (Missouri River).....	2-11
Table A-2.9 Comparison of 1993 Highwater Mark Elevations and Computed Water Surface Elevations (Kansas River).....	2-12
Table A-2.10 Kansas Citys Study Roughness Coefficient Range (Manning's "n" values).....	2-12
Table A-2.11 Kansas Citys Study Missouri River Discharges (Lower Missouri River Control).....	2-14
Table A-2.12 Kansas Citys Study Missouri River Discharges (Upper Missouri River Control).....	2-14
Table A-2.13 Kansas Citys Study Kansas River Discharges (Kansas River Control).....	2-16
Table A-2.14 Kansas Citys Study Kansas River Discharges (Lower Missouri River Control).....	2-16
Table A-2.15 Kansas Citys Study Area Levee Tiebacks.....	2-19

Table A-2.16 North Kansas City Hillside Drainage Ditch Peak Discharge Values.....	2-21
Table A-2.17 Results of Bridge Hydraulic Impact Analysis.....	2-28
Table A-4.1 Observations of Seepage Conditions During 1952 Flooding on the Missouri River at the Kansas Citys flood control project are consistent with these results.....	4-35
Table A-4.2 Effective Strength Data Used for the CH, CL and ML Materials.....	4-36
Table A-4.3 Values Used for Flow Net Transformation on the North Kansas City-Lower Levee Unit.....	4-37
Table A-4.4 Permeability Ratios for Blanket Material Based on Material Type.....	4-37
Table A-4.5 Probabilistic Parameters for Blanket Thickness for the Argentine Levee Unit.....	4-39
Table A-4.6 Armourdale Probabilistic Parameters for the Blanket Thickness Reach 81+00 to 92+23.....	4-40
Table A-4.7 Birmingham Probabilistic Parameters for the Blanket Thickness Reach 189+00 to 220+00.....	4-41
Table A-4.8 CID-KS Probabilistic Parameters for the Blanket Thickness Reach 41+50 to 79+37.....	4-43
Table A-4.9 CID-MO Probabilistic Parameters for the Blanket Thickness Reach 78+00 to 83+00.....	4-44
Table A-4.10 Probabilistic Parameters for Blanket Thickness for the East Bottoms Unit Reach 349+00 to 399+54.....	4-45
Table A-4.11 Probabilistic Parameters for Blanket Thickness for the Fairfax-Jersey Creek Unit Reach 302+00 to 312+25.....	4-46
Table A-4.12 Summary of Risk-based Analyses of Existing Conditions for the Levee Units Considered in the Feasibility Study Giving Station and Probability of Failure (P_f) at the 1993 Flood Elevation and at the Top of Levee	4-49
Table A-5.1 Geotechnical Soil Parameters.....	5-2
Table A-5.2 Permeability Ratios for Blanket Materials.....	5-4

Table A-5.3 Required Underseepage Control for Embankments and Foundation, Nominal 500-Year Level of Protection	5-6
Table A-5.4 Required Underseepage Control for Embankments and Foundation, Nominal 500-Year + 3 Feet Level of Protection.....	5-7
Table A-5.5 Required Underseepage Control for Embankments and Foundation, Nominal 500-Year + 5 Feet Level of Protection.....	5-8
Table A-5.6 Recommended Flood Protection Raise Stability Berm Summary Nominal 500-Year Raise.....	5-11
Table A-5.7 Recommended Flood Protection Raise Stability Berm Summary Nominal 500-Year + 3 Feet Raise	5-12
Table A-5.8 Recommended Flood Protection Raise Stability Berm Summary Nominal 500-Year + 5 Feet Raise	5-13
Table A-6.1 Permeability Ratios for Blanket Materials.....	6-4
Table A-8.1 Soil Profile Immediately Behind the Wall.....	8-3
Table A-8.2 Soil Profile Under Slope and Levee	8-3
Table A-8.3 Soil Parameters Selected for Analysis.....	8-4
Table A-8.4 River Scour Relationship.....	8-6
Table A-8.5 Random Variables for Fairfax-Jersey Creek	8-8
Table A-9.1 Permeability Ratios for Blanket Materials	9-3
Table A-9.2 Existing Conditions Risk and Uncertainty Results.....	9-6
Table A-10.1 Permeability Ratios for Blanket Materials.....	10-4
Table A-10.2 Design Alternatives Considered.....	10-5
Table A-10.3 Existing Conditions Risk and Uncertainty Results.....	10-6
Table A-12.1 Stability Criterion.....	12-11
Table A-12.2 Floodwall Performance.....	12-14
Table A-12.3 Stop Log Gap Performance.....	12-14

Table A-12.4 Gatewell & Outlet Summary	12-15
Table A-12.5 Probability of Failure Values.....	12-16
Table A-12.6 RCB Summary.....	12-17
Table A-13.1 Stability Criterion.....	13-1
Table A-13.2 Nominal 500 yr Floodwall Performance	13-5
Table A-13.3 Stop Log Gap Performance	13-6
Table A-13.4 Factor of Safety for Modified Stop Log Gap 288+57	13-6
Table A-13.5 Gatewell & Outlet Summary	13-8
Table A-13.6 I-Wall Locations	13-9
Table A-13.7 RCB Summary.....	13-10
Table A-14.1 Pile Capacities	14-4
Table A-14.2 Piles Strength.....	14-4
Table A-14.3 Floodwall Strength	14-5
Table A-14.4 Stop Log Analysis	14-7
Table A-15.1 Summary of Pump Station Modifications	15-4
Table A-15.2 Turner Pump Station Capacities for Current Conditions.....	15-8
Table A-15.3 Turner Pump Station Capacities for Future Conditions	15-8
Table A-15.4 Flotation and Bearing Pressure Results.....	15-10
Table A-15.5 Argentine Flotation Analysis Results.....	15-14
Table A-15.6 Existing Conditions Structural Evaluation Results	15-17
Table A-15.7 Existing and Future Conditions Mechanical Evaluation Results	15-18

INDEX TO ENGINEERING APPENDIX EXHIBITS

Exhibit A-1.1 Argentine Unit – Levee/Floodwall Features Inventory.....	1-22
Exhibit A-1.2 Armourdale Unit – Levee/Floodwall Features Inventory.....	1-38
Exhibit A-1.3 Birmingham Unit – Levee/Floodwall Features Inventory.....	1-60
Exhibit A-1.4 CID (Kansas) Unit – Levee/Floodwall Features Inventory.....	1-76
Exhibit A-1.5 CID (Missouri) Unit – Levee/Floodwall Features Inventory.....	1-95
Exhibit A-1.6 East Bottoms Unit – Levee/Floodwall Features Inventory.....	1-109
Exhibit A-1.7 Fairfax-Jersey Creek Unit – Levee/Floodwall Features Inventory.....	1-129
Exhibit A-1.8 North Kansas City (Airport) Unit – Levee/Floodwall Features Inventory.....	1-148
Exhibit A-1.9 North Kansas City (Lower) Unit – Levee/Floodwall Features Inventory.....	1-160
Exhibit A-2.1 USGS Rating Curve #13 – Kansas City Gage.....	2-41
Exhibit A-2.2 Discharge – Frequency Curve – Missouri River just Downstream of Blue River.....	2-42
Exhibit A-2.3 Discharge – Frequency Curve – Missouri River just Downstream of Kansas River.....	2-43
Exhibit A-2.4 Discharge – Frequency Curve – Missouri River just Upstream of Kansas River.....	2-44
Exhibit A-2.5 Discharge – Frequency Curve – Kansas River at Mouth.....	2-45
Exhibit A-2.6 HEC-RAS Schematic of Reaches.....	2-46
Exhibit A-2.7 Missouri River 1993 Computed Water Surface vs. Observed Highwater Marks.....	2-47
Exhibit A-2.8 Kansas River 1993 Computed Water Surface vs. Observed Highwater Marks.....	2-48
Exhibit A-2.9 Missouri River Existing Conditions Higher Probability Water Surface Profiles.....	2-49

Exhibit A-2.10 Missouri River Existing Conditions Lower Probability Water Surface Profiles.....	2-50
Exhibit A-2.11 Birmingham Levee Unit 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-51
Exhibit A-2.12 East Bottoms Levee Unit 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-52
Exhibit A-2.13 Central Industrial District (Missouri) 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-53
Exhibit A-2.14 North Kansas City Airport Levee Unit 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-54
Exhibit A-2.15 Fairfax-Jersey Creek Levee Unit 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-55
Exhibit A-2.16 Kansas River Existing Conditions Higher Probability Water Surface Profiles.....	2-56
Exhibit A-2.17 Kansas River Lower Probability Water Surface Profile.....	2-57
Exhibit A-2.18 Central Industrial District (Kansas) Levee Unit 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-58
Exhibit A-2.19 Armourdale Levee Unit 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-59
Exhibit A-2.20 Argentine Levee Unit 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-60
Exhibit A-2.21 Comparison of Rating Curve #13 and Observed Measurements (1990 – Present).....	2-61
Exhibit A-2.22 Comparison of Rating Curve #13 and Computed Water Surface Elevations.....	2-62
Exhibit A-2.23 Birmingham Unit Levee Tieback Water Surface Profile.....	2-63
Exhibit A-2.24 East Bottom Levee Unit Tieback Water Surface Profile.....	2-64
Exhibit A-2.25 North Kansas City Levee Unit Levee Tieback Water Surface Profile.....	2-65
Exhibit A-2.26 Argentine Levee Unit Interior/Exterior Relationship Source Data.....	2-66

Exhibit A-2.27 Armourdale Levee Unit Interior/Exterior Relationship Source Data.....	2-67
Exhibit A-2.28 Birmingham Levee Unit Interior/Exterior Relationship Source Data.....	2-68
Exhibit A-2.29 Central Industrial District (Kansas) Levee Unit Interior/Exterior Relationship Source Data.....	2-69
Exhibit A-2.30 Central Industrial District (Missouri) Levee Unit Interior/Exterior Relationship Source Data.....	2-70
Exhibit A-2.31 East Bottoms Levee Unit Interior/Exterior Relationship Source Data.....	2-71
Exhibit A-2.32 Fairfax-Jersey Creek Levee Unit Interior/Exterior Relationship Source Data.....	2-72
Exhibit A-2.33 North Kansas City Levee Unit Interior/Exterior Relationship Source Data.....	2-73
Exhibit A-2.34 Argentine Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Relationship.....	2-74
Exhibit A-2.35 Armourdale Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Relationship.....	2-75
Exhibit A-2.36 Birmingham Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Relationship.....	2-76
Exhibit A-2.37 CID (Kansas) Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Elevation Relationship...2-77	
Exhibit A-2.38 CID (Missouri) Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Elevation Relationship...2-78	
Exhibit A-2.39 East Bottoms Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Elevation Relationship...2-79	
Exhibit A-2.40 Fairfax-Jersey Creek Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Elevation Relationship...2-80	
Exhibit A-2.41 North Kansas City Levee Unit – Combined Levee Failure and Overtopping Interior/Exterior Water Surface Elevation Relationship...2-81	
Exhibit A-2.42 Schematic of Argentine Levee Unit Interior Hydrology.....	2-82

Exhibit A-2.43 Schematic of Armourdale Levee Unit Interior Hydrology.....	2-83
Exhibit A-2.44 Schematic of Birmingham Levee Unit Interior Hydrology.....	2-84
Exhibit A-2.45 Schematic of Central Industrial District Levee Unit Interior Hydrology.....	2-85
Exhibit A-2.46 Schematic of East Bottoms Levee Unit Interior Hydrology.....	2-86
Exhibit A-2.47 Schematic of Fairfax-Jersey Creek Levee Unit Interior Hydrology	2-87
Exhibit A-2.48 Schematic of North Kansas City Levee Unit Interior Hydrology.....	2-88
Exhibit A-2.49 Argentine Levee Unit Interior Stormwater Flood Volumes – Turner Station 60+40.....	2-89
Exhibit A-2.50 Argentine Levee Unit Interior Stormwater Flood Volumes – Con Agra Pump Plant 145+00.....	2-90
Exhibit A-2.51 Argentine Levee Unit Interior Stormwater Flood Volumes – Santa Fe Drainage Ditch 253+14.....	2-91
Exhibit A-2.52 Armourdale Levee Unit Interior Stormwater Flood Volumes – Osage Avenue Pumping Plant 82+30.....	2-92
Exhibit A-2.53 Armourdale Levee Unit Interior Stormwater Flood Volumes – 12 th Street Sewer System 129+30.....	2-93
Exhibit A-2.54 Armourdale Levee Unit Interior Stormwater Flood Volumes – Mill Street Pumping Plant 156+75.....	2-94
Exhibit A-2.55 Armourdale Levee Unit Interior Stormwater Flood Volumes – Shawnee Avenue Pumping Plant 230+77	2-95
Exhibit A-2.56 Armourdale Levee Unit Interior Stormwater Flood Volumes – Splitlog Outfall 311+10.....	2-96
Exhibit A-2.57 Central Industrial District (Kansas) Levee Unit Interior Stormwater Flood Volumes – Ohio Avenue Pump Plant -5+85.....	2-97
Exhibit A-2.58 East Bottoms Levee Unit Interior Stormwater Flood Volumes – Prospect Avenue Pump Station 93+36.....	2-98
Exhibit A-2.59 East Bottoms Levee Unit Interior Stormwater Flood Volumes – Milwaukee Pump Station 172+00.....	2-99

Exhibit A-2.60 East Bottoms Levee Unit Interior Stormwater Flood Volumes – Hawthorn Pump Station 401+00.....	2-100
Exhibit A-2.61 Birmingham Levee Unit Interior Stormwater Flood Volumes – Birmingham Pump Plant 434+21.....	2-101
Exhibit A-2.62 Birmingham Levee Unit Interior Stormwater Flood Volumes – Southeastern Drainage 288+70.....	2-102
Exhibit A-2.63 Central Industrial District (Missouri) Interior Stormwater Flood Volumes – Santa Fe Pump Plant 52+87.....	2-103
Exhibit A-2.64 Fairfax-Jersey Creek Levee Unit Interior Stormwater Flood Volumes – Pump Plant F-1 267+70.....	2-104
Exhibit A-2.65 North Kansas City Levee Unit Interior Stormwater Flood Volumes – Rock Creek Pump Plant 388+96.....	2-105
Exhibit A-2.66 Inundation Map for Turner Station.....	2-106
Exhibit A-2.67 Inundation Map for Con Agra Pump Plant.....	2-107
Exhibit A-2.68 Inundation Map for Santa Fe Drainage Ditch.....	2-108
Exhibit A-2.69 Inundation Map for Mill Street Pump Plant.....	2-109
Exhibit A-2.70 Inundation Map for Shawnee Avenue Pump Plant.....	2-110
Exhibit A-2.71 Inundation Map for Splitlog Outfall.....	2-111
Exhibit A-2.72 Inundation Map for Ohio Avenue Pump Plant.....	2-112
Exhibit A-2.73 Inundation Map for Milwaukee Pump Plant.....	2-113
Exhibit A-2.74 Inundation Map for Hawthorn Pump Plant.....	2-114
Exhibit A-2.75 Inundation Map for Prospect Avenue Pump Plant.....	2-115
Exhibit A-2.76 Inundation Map for Birmingham Pump Plant.....	2-116
Exhibit A-2.77 Inundation Map for Rock Creek Pump Plant.....	2-117
Exhibit A-2.78 Bridge Removals.....	2-118
Exhibit A-2.79 Missouri River Stage Trends at Kansas City, Missouri for High Frequency Flows.....	2-119

Exhibit A-2.80 Missouri River Stage Trends at Kansas City, Missouri for Low Frequency Flows.....	2-120
Exhibit A-2.81 Missouri River Near the Hannibal Bridge 1951, Kansas City, Missouri and Kansas.....	2-121
Exhibit A-2.82 Missouri River Near the Hannibal Bridge 1998, Kansas City, Missouri and Kansas.....	2-122
Exhibit A-2.83 Missouri River Near the Hannibal Bridge 1954, Kansas City, Missouri and Kansas.....	2-123
Exhibit A-2.84 Kansas River 1955, Kansas City, Missouri and Kansas.....	2-124
Exhibit A-2.85 Kansas River 1955, Kansas City, Missouri and Kansas (2).....	2-125
Exhibit A-2.86 Kansas River 1998, Kansas City, Missouri and Kansas.....	2-126
Exhibit A-2.87 Missouri River Future Conditions Without Project Higher Probability Water Surface Profiles.....	2-127
Exhibit A-2.88 Missouri River Future Conditions Without Project Lower Probability Water Surface Profiles.....	2-128
Exhibit A-2.89 Kansas River Future Conditions Without Project Higher Probability Water Surface Profiles.....	2-129
Exhibit A-2.90 Kansas River Future Conditions Without Project Lower Probability Water Surface Profiles.....	2-130
Exhibit A-2.91 Birmingham Levee Unit Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-131
Exhibit A-2.92 East Bottoms Levee Unit Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-132
Exhibit A-2.93 Central Industrial District (Missouri) Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-133
Exhibit A-2.94 North Kansas City Airport Levee Unit Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-134
Exhibit A-2.95 Fairfax-Jersey Creek Levee Unit Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-135

Exhibit A-2.96 CID (Kansas) Unit Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-136
Exhibit A-2.97 Armourdale Unit Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-137
Exhibit A-2.98 Argentine Unit Future Conditions Without Project 0.2% (500-Year) Chance of Exceedance Water Surface Profile.....	2-138
Exhibit A-2.99 Hawthorne Pumping Plant Tributary Area From 2000 DRG Bayer Site Drainage Study.....	2-139
Exhibit A-2.100 Hawthorne Pumping Plant Tributary Area From 1948 East Bottoms Unit Supplement on Interior Drainage.....	2-140
Exhibit A-2.101 Kansas River Future Conditions With Tree Removal 0.2% (500-Year) Chance of Exceedance Water Surface Profiles.....	2-141
Exhibit A-2.102 Kansas River Future Conditions With Tree Removal and Channel Modification 0.2% (500-Year) Chance of Exceedance Water Surface Profiles.....	2-142
Exhibit A-2.103 Summary of Bridges and Sources of Bridge Drawings.....	2-143
Exhibit A-2.104 Summary of Surveyed Top-of-Levee Elevations.....	2-144
Exhibit A-2.105 Missouri River Existing Conditions Water Surface Elevations.....	2-148
Exhibit A-2.106 Kansas River Existing Conditions Water Surface Elevations.....	2-168
Exhibit A-2.107 Drainage Control Structure Preliminary Screening.....	2-180
Exhibit A-2.108 Sources of Data for Drainage Control Structure Interior Stormwater Hydraulic Modeling.....	2-181
Exhibit A-2.109 Drainage Control Structure Interior Area Stormwater Flood Volumes.....	2-182
Exhibit A-2.110 Critical Drainage Control Structure Screening.....	2-183
Exhibit A-2.111 Ranking of Bridges Based on Kansas River Water Surface Elevation Losses.....	2-184
Exhibit A-2.112 Missouri River Future Conditions Without Project Water Surface Elevations.....	2-185

Exhibit A-2.113 Kansas River Future Conditions Without Project Water Surface Elevations.....	2-205
Exhibit A-2.114 Kansas River Future Conditions With Tree Removal Alternative Water Surface Elevations.....	2-217
Exhibit A-2.115 Kansas River Future Conditions With Tree Removal and Channel Modifications Water Surface Elevations.....	2-229
Exhibit A-2.116 Relationship Between Peak Flood Flows From The Kansas and Missouri Rivers.....	2-241
Exhibit A-2.117 Induced Damages Memorandum For Record.....	2-260
Exhibit A-3.1 Kansas City, Missouri and Kansas, Flood Damage Reduction Report Feasibility Study Currency of Aquired Data.....	3-6
Exhibit A-4.1 Typical shape of the normal probability distribution function showing the expected value or mean, $E[X]$	4-29
Exhibit A-4.2 Typical shape of the log-normal distribution function showing the expected value, $E[X]$	4-30
Exhibit A-4.3 Hypothetical normal probability distribution showing the probabilistic parameters.....	4-31
Exhibit A-4.4 Normal probability distribution for the natural log of the factor of safety, assuming that the factor of safety is log-normally distributed.....	4-32
Exhibit A-4.5 Normal probability distribution for the natural log of the hydraulic gradient, assuming that the hydraulic gradient is log-normally distributed where the failure gradient is defining the limit state.....	4-33
Exhibit A-4.6 The probability distribution curve illustrating the assumptions used in developing the Taylor Series Approximation.....	4-34
Exhibit A-4.7 Typical Bi-linear Strength Envelope.....	4-38
Exhibit A-4.8 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the Argentine Unit.....	4-40
Exhibit A-4.9 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the Armourdale Unit.....	4-41

Exhibit A-4.10 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the Birmingham Unit.....	4-42
Exhibit A-4.11 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the CID-KS Unit.....	4-44
Exhibit A-4.12 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the CID-MO Unit.....	4-45
Exhibit A-4.13 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the East Bottoms Unit.....	4-46
Exhibit A-4.14 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the Fairfax-Jersey Creek Unit.....	4-47
Exhibit A-4.15 Probability of Failure Due to Underseepage, Slope Stability and the Combined Probability for the NKC Lower Unit.....	4-48
Exhibit A-5.1 Argentine Unit 500-Yr Nominal Water Surface with Existing TOL	5-20
Exhibit A-5.2 Underseepage Analysis Nominal 500-Year.....	5-22
Exhibit A-5.3 Berm Design Information Nominal 500-Year	5-24
Exhibit A-5.4 Argentine Unit 500-Yr With Survey Data Added.....	5-26
Exhibit A-5.5 500-Yr Station 54+00 - Stability Analysis without Berm.....	5-37
Exhibit A-5.6 500-yr Station 61+00 -Stability Analysis with Berms.....	5-38
Exhibit A-5.7 500-yr Station 118+00 - Stability Analysis without Berms.....	5-39
Exhibit A-5.8 500-yr Station 118+00 - Stability Analysis with Berms.....	5-40
Exhibit A-5.9 500-yr Station 118+00 - Stability Analysis with Berms.....	5-41
Exhibit A-5.10 500-yr Station 257+00 - Stability Analysis with Berms.....	5-42
Exhibit A-5.11 500-yr Station 265+00 - Stability Analysis without Berms No Rock Face.....	5-43
Exhibit A-5.12 500-yr Station 265+00 - Stability Analysis without Berms Rock Face.....	5-44
Exhibit A-5.13 500-yr Station 265+00 - Stability Analysis without Berms.....	5-45

Exhibit A-5.14 500-yr Station 265+00 - Stability Analysis Hydraulic Grade Line....	5-46
Exhibit A-5.15 Assumed 500 yr Flood Elevation Station 0+00 to 39+00.....	5-48
Exhibit A-5.16 Argentine Levee Raise N500+3	5-49
Exhibit A-5.17 Argentine Levee Raise N500+3 (2).....	5-50
Exhibit A-5.18 Argentine Levee Raise N500+3 (3).....	5-51
Exhibit A-5.19 Underseepage Analysis Nominal 500-Year + 3 Feet.....	5-53
Exhibit A-5.20 Berm Design Information Nominal 500-Year + 3 Feet.....	5-55
Exhibit A-5.21 Argentine Unit 500-yr With Survey Data Added.....	5-57
Exhibit A-5.22 500-yr + 3 ft. Station 54+00 - Stability Analysis with Berms.....	5-65
Exhibit A-5.23 500 yr + 3 ft. Station 61+00 - Stability Analysis with Berms.....	5-66
Exhibit A-5.24 500-yr + 3 ft. Station 118+00 - Stability Analysis with Berms.....	5-67
Exhibit A-5.25 500-yr + 3 ft. Station 264+00 – Existing Condition Stability Analysis.....	5-68
Exhibit A-5.26 500-yr + 3 ft. Station 264+00 – Proposed Condition Stability Analysis.....	5-92
Exhibit A-5.27 Assumed 500-yr Flood Elevation Station 0+00 to 39+00.....	5-119
Exhibit A-5.28 Argentine Feasibility Cross Section N500+5.....	5-120
Exhibit A-5.29 Argentine Feasibility Cross Section N500 + 5 (2).....	5-121
Exhibit A-5.30 Argentine Feasibility Cross Section N500 + 5 (3).....	5-122
Exhibit A-5.31 Argentine Feasibility Cross Section N500 + 5 (4).....	5-123
Exhibit A-5.32 Underseepage Analysis Nominal 500-Year + 5 Feet.....	5-125
Exhibit A-5.33 Berm Design Information Nominal 500-Year + 5 Feet.....	5-127
Exhibit A-5.34 Argentine Unit 500-yr With Survey Data Added.....	5-129
Exhibit A-5.35 Underseepage Analysis Station 265+00	5-136

Exhibit A-5.36 Well Design Calculations.....	5-137
Exhibit A-5.37 Well Design Calculations (2).....	5-138
Exhibit A-5.38 Well Design Calculations (3).....	5-139
Exhibit A-5.39 Well Design Calculations (4).....	5-140
Exhibit A-5.40 Hydraulic Grade Line for Station 265+00 Argentine Kansas.....	5-141
Exhibit A-5.41 Hydraulic Grade Line for Station 265+00 Slope Stability At Base of Blanket Nominal 500-Yr + 5 Feet Argentine Unit.....	5-142
Exhibit A-5.42 500-yr + 5 ft. Station 54+00 - Stability Analysis with Berms (Typical Sta. 2+00 to 60+00).....	5-144
Exhibit A-5.43 500-yr + 5 ft. Station 61+00 - Stability Analysis with Berms (Typical Sta. 61+00 to 117+00).....	5-145
Exhibit A-5.44 500-yr + 5 ft. Station 118+00 - Stability Analysis without Berms (Typical Sta. 118+00 to 182+20).....	5-146
Exhibit A-5.45 500-yr + 5 ft. Station 183+00 - Stability Analysis with Berms (Typical Sta. 182+20 to 253+00).....	5-147
Exhibit A-5.46 500-yr + 5 ft. Station 265+00 - Stability Analysis without Berms (Typical Sta. 258+00 to 276+70).....	5-148
Exhibit A-5.47 500-yr + 5 ft. Station 265+00 - Stability Analysis without Berms with I Walls(Typical Sta. 258+00 to 276+70).....	5-149
Exhibit A-5.48 500-yr + 5 ft. Station 257+00 - Stability Analysis with Berms (Typical Sta. 254+00 to 264+00).....	5-150
Exhibit A-5.49 500-yr + 5 ft. Station 265+00 - Stability Analysis with Berms (Typical Sta. 265+00 to 276+70).....	5-151
Exhibit A-5.50 500-yr + 5 ft. Station 265+00 - Stability Analysis with Berms (Typical Sta. 265+00 to 276+70).....	5-152
Exhibit A-5.51 Hydraulic Grade Line for the Station 265+00 Slope Stability At Base of Blanket Nominal 500 yr + 5 Feet Argentine Unit.....	5-153
Exhibit A-5.52 Hydraulic Grade Line for the Station 265+00 Wall Argentine Unit.....	5-154

Exhibit A-5.53 Hydraulic Grade Line for the Station 265+00 Wall Argentine Unit (2).....	5-155
Exhibit A-5.54 1962 – Mod Design Data – Silts.....	5-157
Exhibit A-5.55 Kansas City, Kansas – 1962 MOD Argentine Unit.....	5-158
Exhibit A-5.56 Kansas City, Kansas – 1962 MOD Argentine Unit (2).....	5-159
Exhibit A-5.57 1962 – Mod Design Data – Clays.....	5-160
Exhibit A-5.58 Kansas City, Kansas – 1962 MOD Argentine Unit (3).....	5-161
Exhibit A-5.59 Kansas City, Kansas – 1962 MOD Argentine Unit (4).....	5-162
Exhibit A-5.60 Kansas City, Kansas – 1962 MOD Argentine Unit (5).....	5-163
Exhibit A-5.61 Kansas City, Kansas – 1962 MOD Argentine Unit (6).....	5-164
Exhibit A-5.62 1962 – Mod Design Data – Levee Impervious.....	5-165
Exhibit A-5.63 Kansas City, Kansas – 1962 Mod Argentine Unit.....	5-166
Exhibit A-5.64 Kansas City, Kansas – 1962 Mod Argentine Unit (2).....	5-167
Exhibit A-5.65 Kansas City, Kansas – 1962 Mod Argentine Unit (3).....	5-168
Exhibit A-5.66 Kansas City, Kansas – 1962 Mod Argentine Unit (4).....	5-169
Exhibit A-5.67 L-385 Information.....	5-170
Exhibit A-6.1 Plan View of East Bottoms.....	6-10
Exhibit A-6.2 Typical Cross Section Station 0+00 to Station 57+26.02.....	6-11
Exhibit A-6.3 Typical Cross Section Station 57+14 to Station 74+56.....	6-12
Exhibit A-6.4 Typical Cross Section Station 74+44.17 to Station 85+00.....	6-13
Exhibit A-6.5 Typical Cross Section Station 85+00 to Station 140+00.....	6-14
Exhibit A-6.6 Typical Cross Section Station 140+00 to Station 174+27.5.....	6-15
Exhibit A-6.7 Typical Cross Section Station 174+27.5 to Station 285+00.....	6-16
Exhibit A-6.8 Typical Cross Section Station 285+00 to Station 375+00.....	6-17

Exhibit A-6.9 Typical Cross Section Station 375+00 to Station 404+00 and Station 433+00 to Station 454+00.....	6-18
Exhibit A-6.10 Typical Cross Section Station 404+00 to Station 406+00 And Typical Transition Cross Section Station 406+00 to Station 410+00.....	6-19
Exhibit A-6.11 Typical Cross Section Station 410+00 to Station 416+00	6-20
Exhibit A-6.12 Typical Cross Section Station 416+00 to Station 433+00.....	6-21
Exhibit A-6.13 Typical Cross Section Station 454+70 to Station 478+00.....	6-22
Exhibit A-6.14 Typical Cross Section Station 488+00 to Station 477+83.....	6-23
Exhibit A-6.15 Details of Drainage System Record Drawing.....	6-24
Exhibit A-6.16 Aerial View of Buried Collector System.....	6-26
Exhibit A-6.17 Aerial View of Missouri and Blue Rivers Confluence Area.....	6-27
Exhibit A-6.18 Floodwall Record Drawing.....	6-28
Exhibit A-6.19 Plan and Profile Operational Drawing.....	6-29
Exhibit A-6.20 Plan and Profile Operational Drawing (2)	6-30
Exhibit A-6.21 Plan and Profile Operational Drawing (3)	6-31
Exhibit A-6.22 Plan and Profile Operational Drawing (4)	6-32
Exhibit A-6.23 Boring Profiles from Record Drawing.....	6-33
Exhibit A-6.24 Boring Profiles from Record Drawing (2).....	6-34
Exhibit A-6.25 Underseepage Analysis Calculations	6-36
Exhibit A-6.26 Underseepage Analysis Calculations (2)	6-37
Exhibit A-6.27 Berm Design Information	6-38
Exhibit A-6.28 Berm Design Information (2).....	6-39
Exhibit A-6.29 Proposed Relief Wells at Missouri and Blue Rivers Confluence Area	6-41

Exhibit A-6.30 Well Design Calculations	6-42
Exhibit A-6.31 Well Design Calculations (2).....	6-43
Exhibit A-6.32 Well Design Calculations (3).....	6-44
Exhibit A-6.33 Well Design Calculations (4).....	6-45
Exhibit A-6.34 Well Design Calculations (5).....	6-46
Exhibit A-7.1 Plan View of Fairfax-Jersey Creek Unit.....	7-6
Exhibit A-7.2 Plan and Section As-Built of BPU Floodwall.....	7-7
Exhibit A-7.3 Bank Protection at BPU Area As-Built	7-8
Exhibit A-7.4 Concrete Details at BPU Floodwall As-Built	7-9
Exhibit A-7.5 Levee Section and Floodwall Details Record Drawing.....	7-10
Exhibit A-7.6 Typical Levee Cross-Sections Record Drawing.....	7-11
Exhibit A-7.7 Typical Levee Cross-Sections Record Drawing (2)	7-12
Exhibit A-7.8 Typical Levee Cross-Sections Record Drawing (3)	7-13
Exhibit A-7.9 Fairfax Levee Cross-Sections As-Built	7-14
Exhibit A-7.10 Fairfax Levee Cross-Sections As-Built (2).....	7-15
Exhibit A-7.11 Fairfax Levee Cross-Sections As-Built (3).....	7-16
Exhibit A-7.12 Plan and Profile Operational Drawing.....	7-18
Exhibit A-7.13 Plan and Profile Operational Drawing (2)	7-19
Exhibit A-7.14 Floodwall Pile Investigation Report	7-20
Exhibit A-7.15 Fairfax-Jersey Creek Flood Wall Pile Foundation Documentation.....	7-38
Exhibit A-7.16 Fairfax-Jersey Creek Flood Wall Flownet.....	7-49
Exhibit A-7.17 Guidance for Ultimate Capacity of Driven Piles	7-51
Exhibit A-7.18 Fairfax Field Blow Counts, Uncorrected	7-52

Exhibit A-7.19 Relationship Between Angle of Internal Friction and Blow Count.....	7-53
Exhibit A-7.20 Relationship Between Overburden Pressure and Blow Count	7-54
Exhibit A-7.21 Blow Count and Shear Strength Calculations.....	7-55
Exhibit A-7.22 Blow Count and Shear Strength Calculations (2).....	7-58
Exhibit A-7.23 Blow Count and Shear Strength Calculations (3).....	7-61
Exhibit A-7.24 Summary of Ultimate Foundation Resistance	7-64
Exhibit A-8.1 River Scour Relationship	8-5
Exhibit A-8.2 Probability of Wall Failure, P_{rf1} Versus River Bed Scour	8-7
Exhibit A-8.3 Probability of Foreshore Failure, P_{rf2} Versus River Elevation	8-9
Exhibit A-8.4 Probability of Levee with I-Wall Failure P_{rf3} Versus River Elevation	8-10
Exhibit A-8.5 Probability of Failure for Levee Section 27+50 P_{rf4} Versus River Elevation	8-11
Exhibit A-8.6 Plan and Profile of Sheet Pile Study Reach.....	8-15
Exhibit A-8.7 Plan and Profile of Jersey Creek Sewer.....	8-16
Exhibit A-8.8 Fairfax Levee Cross Section at Station 25+14.....	8-17
Exhibit A-8.9 General Plan of Sheet Pile Walls.....	8-18
Exhibit A-8.10 Elevations of Sheet Pile Walls.....	8-19
Exhibit A-8.11 Typical Details of Sheet Pile Walls	8-20
Exhibit A-8.12 Modification to Existing Protection Plan and Profile	8-21
Exhibit A-8.13 Modification to Existing Protection Plan Station 15+75 to Station 23+10.....	8-22
Exhibit A-8.14 Modification to Existing Protection Plan Station 23+10 to Station 29+77	8-23
Exhibit A-8.15 Modification to Existing Protection Typical Levee Sections and Wall Details.....	8-24

Exhibit A-8.16 Survey of Station 27+50 Area	8-25
Exhibit A-8.17 Cross-Section of Modeled Area.....	8-26
Exhibit A-8.18 Schematic of Failure Model.....	8-27
Exhibit A-8.19 Bed Scour Relationship Versus River Stage.....	8-28
Exhibit A-8.20 Probability of Excessive Moment for Simple Cantilever Wall vs. Bed Scour	8-29
Exhibit A-8.21 Summary of Probability of Flood Protection Failure Station 25+00 for River Elevation 750 Feet	8-30
Exhibit A-8.22 Simple Cantilever Wall Model for River Elevation of 750 Feet	8-31
Exhibit A-8.23 Summary of Probability of Foreshore Global Stability Failure Using River Elevation 750 Feet.....	8-36
Exhibit A-8.24 Mean Value Analysis of Global Stability of Station 25+00 Foreshore With River Elevation 750 Feet	8-37
Exhibit A-8.25 Mean Value Analysis of Global Stability Foreshore UTEXAS4 Output File	8-38
Exhibit A-8.26 Summary of Probability of Levee/I-Wall Global Stability Failure Using River Elevation 750 Feet.....	8-54
Exhibit A-8.27 Mean Value of Global Stability of Station 25+00 Levee/I-Wall With River Elevation 750 Feet	8-55
Exhibit A-8.28 Mean Value Analysis of Global Stability Levee/I-Wall UTEXAS4 Output File	8-56
Exhibit A-8.29 Summary of Probability of Flood Protection Failure for Station 25+00 for River Elevation 755 Feet	8-72
Exhibit A-8.30 Simple Cantilever Wall Model for River Elevation 755 Feet.....	8-73
Exhibit A-8.31 Summary of Probability of Foreshore Global Stability Failure Using River Elevation 755 Feet.....	8-78
Exhibit A-8.32 Mean Value Analysis of Global Stability of Station 25+00 Foreshore With River Elevation 755 Feet	8-79

Exhibit A-8.33 Mean Value Analysis of Global Stability Foreshore UTEXAS4 Output File	8-80
Exhibit A-8.34 Summary of Probability of Levee/I-Wall Global Stability Failure Using River Elevation 755 Feet.....	8-96
Exhibit A-8.35 Mean Value Analysis of Global Stability of Station 25+00 Levee/I-Wall With River Elevation 755 Feet	8-97
Exhibit A-8.36 Mean Value Analysis of Global Stability Levee/I-Wall UTEXAS4 Output File	8-98
Exhibit A-8.37 Summary of Probability of Flood Protection Failure for Station 25+00 for River Elevation 760.5 Feet	8-114
Exhibit A-8.38 Simple Cantilever Wall Model for River Elevation 760.5 Feet.....	8-115
Exhibit A-8.39 Summary of Probability of Foreshore Global Stability Failure Using river Elevation 760.5 Feet	8-120
Exhibit A-8.40 Summary of Probability of Levee/I-Wall Global Station Failure Using River Elevation 760.5 Feet.....	8-121
Exhibit A-8.41 Mean Value Analysis of Global Stability of Station 25+00 Levee/I-Wall With River Elevation 760.5 Feet	8-122
Exhibit A-8.42 Mean Value Analysis of Global Stability Levee/I-Wall UTEXAS4 Output File	8-123
Exhibit A-8.43 Hydraulic Data Used in the Prediction of Bed Scour	8-139
Exhibit A-8.44 Missouri River Future Conditions Without Project Water Surface Elevations.....	8-142
Exhibit A-9.1 Plan View of North Kansas City Unit.....	9-10
Exhibit A-9.2 Typical Levee Cross-Sections.....	9-11
Exhibit A-9.3 Typical Levee Cross-Sections (2).....	9-12
Exhibit A-9.4 Typical Levee Cross-Sections (3).....	9-13
Exhibit A-9.5 Typical Levee Cross-Sections (4).....	9-14
Exhibit A-9.6 Typical Levee Cross-Sections (5).....	9-15

Exhibit A-9.7 Typical Levee Cross-Sections (6).....	9-16
Exhibit A-9.8 Cross-Section of Levee Looking NNW	9-18
Exhibit A-9.9 Cross-Section of Collector Drain for Harlem Section	9-19
Exhibit A-9.10 Cross-Section of Levee Looking ENE.....	9-20
Exhibit A-9.11 Plan and Profile Record Drawing	9-21
Exhibit A-9.12 Plan and Profile Record Drawing (2).....	9-22
Exhibit A-9.13 Soil Depth Chart	9-23
Exhibit A-9.14 Plan and Profile Record Drawing (3).....	9-24
Exhibit A-9.15 Plan and Profile Record Drawing (4).....	9-25
Exhibit A-9.16 Soil Depth Chart (2).....	9-26
Exhibit A-9.17 Soil Depth Chart (3).....	9-27
Exhibit A-9.18 Plan and Profile Record Drawing (5).....	9-28
Exhibit A-9.19 Plan and Profile Record Drawing (6).....	9-29
Exhibit A-9.20 Plan and Profile Record Drawing (7).....	9-30
Exhibit A-9.21 Soil Depth Chart (4).....	9-31
Exhibit A-9.22 Plan and Profile Record Drawing (8).....	9-32
Exhibit A-9.23 Plan and Profile Record Drawing (9).....	9-33
Exhibit A-9.24 Plan and Profile Record Drawing (10).....	9-34
Exhibit A-9.25 Plan and Profile Record Drawing (11).....	9-35
Exhibit A-9.26 Underground Explorations Record Drawing	9-36
Exhibit A-9.27 Plan and Profile Record Drawing (12).....	9-37
Exhibit A-9.28 Plan and Profile Record Drawing (13).....	9-38
Exhibit A-9.29 Underground Explorations Record Drawing (2).....	9-39

Exhibit A-9.30 Underground Explorations Record Drawing (3).....	9-40
Exhibit A-9.31 Plan and Profile Record Drawing (14).....	9-41
Exhibit A-9.32 Underground Explorations Record Drawing (4).....	9-42
Exhibit A-9.33 Rock Creek Pump Plant Underground Explorations	9-43
Exhibit A-9.34 Plan and Profile Operational Drawing.....	9-44
Exhibit A-9.35 Borrow Pits Record Drawing.....	9-45
Exhibit A-9.36 1993 Water Surface Elevation E-Mail.....	9-47
Exhibit A-9.37 Underseepage Berm Design Explanation	9-48
Exhibit A-9.38 Demolition Plan for the Addition of Berms.....	9-49
Exhibit A-9.39 Underseepage Analysis Calculations	9-50
Exhibit A-9.40 Berm Design Information	9-51
Exhibit A-9.41 Revised Underseepage Analysis Calculations	9-52
Exhibit A-9.42 Revised Underseepage Analysis Calculations (2)	9-53
Exhibit A-9.43 Excess Head vs. Distance From Toe of Levee Graph	9-54
Exhibit A-9.44 Station 235+00 Existing Conditions	9-55
Exhibit A-9.45 Probability of Failure Underseepage Calculations	9-56
Exhibit A-9.46 Probability of Failure Underseepage Calculations (2).....	9-57
Exhibit A-9.47 Probability of Failure Underseepage Calculations (3).....	9-58
Exhibit A-9.48 Probability of Failure Underseepage Calculations (4).....	9-59
Exhibit A-9.49 Probability of Failure Underseepage Calculations (5).....	9-60
Exhibit A-9.50 Probability of Failure Underseepage Calculations (6).....	9-61
Exhibit A-9.51 Probability of Failure Underseepage Calculations (7).....	9-62
Exhibit A-9.52 Missouri River Existing Conditions Water Surface Elevations.....	9-63

Exhibit A-9.53 Storm Drainage Master Plan.....	9-64
Exhibit A-10.1 Plan and Profile Operational Drawing for National Starch	10-11
Exhibit A-10.2 Profile of Soils	10-12
Exhibit A-10.3 Typical Levee Cross-Sections Record Drawing for National Starch Station 242+80 to Station 257+00	10-13
Exhibit A-10.4 Typical Levee Cross-Sections Record Drawing for National Starch Station 257+00 to Station 271+00	10-14
Exhibit A-10.5 Station 257+00 to Station 271+00 Existing Conditions Cross-Section	10-15
Exhibit A-10.6 Underseepage Calculations for National Starch Berm Design	10-16
Exhibit A-10.7 Underseepage Calculations for National Starch Well Design	10-19
Exhibit A-10.8 Probability of Failure Calculations for National Starch	10-22
Exhibit A-10.9 Probability of Failure Calculations for National Starch (2).....	10-23
Exhibit A-10.10 Probability of Failure Calculations for National Starch (3).....	10-24
Exhibit A-10.11 Probability of Failure Calculations for National Starch (4).....	10-25
Exhibit A-10.12 Probability of Failure Calculations for National Starch (5).....	10-26
Exhibit A-10.13 Probability of Failure Calculations for National Starch (6).....	10-27
Exhibit A-10.14 Well Design Calculations for National Starch.....	10-28
Exhibit A-10.15 Well Design Calculations for National Starch (2)	10-29
Exhibit A-10.16 Missouri River Existing Conditions Water Surface Elevations.....	10-30
Exhibit A-11.1 Argentine Unit Bridge Matrix.....	11-17
Exhibit A-11.2 Borrow Area Designation for Proposed Argentine Unit Raise	11-18
Exhibit A-11.3 Kansas City's Levee Utility Criteria.....	11-38
Exhibit A-11.4 500 Year Flood Event	11-41
Exhibit A-11.5 500 Year Flood Event (2)	11-42

Exhibit A-11.6 500 Year Flood Event + 3 ft	11-43
Exhibit A-11.7 500 Year Flood Event + 3 ft (2).....	11-44
Exhibit A-11.8 500 Year Flood Event + 5 ft	11-45
Exhibit A-11.9 Argentine Uplift N500+0.....	11-46
Exhibit A-11.10 Argentine Uplift N500+3.....	11-47
Exhibit A-11.11 Argentine Uplift N500+5.....	11-48
Exhibit A-11.12 Argentine Unit Utility Crossing Relocations.....	11-49
Exhibit A-11.13 Argentine Unit Utility Crossing Detail.....	11-50
Exhibit A-11.14 Argentine Tower Photo.....	11-51
Exhibit A-11.15 Argentine Utility Uplift.....	11-52
Exhibit A-11.16 Argentine Utility Uplift (2).....	11-53
Exhibit A-11.17 Argentine Utility Uplift (3).....	11-54
Exhibit A-11.18 Argentine Utility Uplift (4).....	11-55
Exhibit A-11.19 Argentine Utility Uplift (5).....	11-56
Exhibit A-11.20 Argentine Utility Uplift (6).....	11-57
Exhibit A-11.21 Argentine Utility Uplift (7).....	11-58
Exhibit A-11.22 Argentine Utility Uplift (8).....	11-59
Exhibit A-11.23 Argentine Utility Uplift (9).....	11-60
Exhibit A-11.24 Argentine Utility Uplift (10).....	11-61
Exhibit A-11.25 Argentine Utility Uplift (11).....	11-62
Exhibit A-11.26 Argentine Utility Uplift (12).....	11-63
Exhibit A-11.27 Argentine Utility Uplift (13).....	11-64
Exhibit A-11.28 Argentine Utility Uplift (14).....	11-65

Exhibit A-11.29 Argentine Utility Uplift (15).....	11-66
Exhibit A-11.30 Argentine Utility Uplift (16).....	11-67
Exhibit A-11.31 Argentine Utility Uplift (17).....	11-68
Exhibit A-11.32 Argentine Utility Uplift (18).....	11-69
Exhibit A-11.33 Argentine Utility Uplift (19).....	11-70
Exhibit A-11.34 Argentine Utility Uplift (20).....	11-71
Exhibit A-11.35 Harlem Area Collector System	11-72
Exhibit A-11.36 North Kansas City-Lower (Harlem Area) Calculations.....	11-73
Exhibit A-11.37 Fairfax-Jersey Creek (BPU Floodwall)	11-99
Exhibit A-11.38 Fairfax-Jersey Creek (BPU Floodwall) (2).....	11-100
Exhibit A-11.39 Fairfax-Jersey Creek (BPU Floodwall) (3).....	11-101
Exhibit A-11.40 Fairfax-Jersey Creek (BPU Floodwall) (4).....	11-102
Exhibit A-11.41 Fairfax-Jersey Creek (BPU Floodwall) (5).....	11-103
Exhibit A-11.42 Fairfax-Jersey Creek (BPU Floodwall) (6).....	11-104
Exhibit A-11.43 East Bottoms (Missouri and Blue Rivers Confluence Area)	11-105
Exhibit A-11.44 East Bottoms Utilities Uplift (Missouri and Blue Rivers Confluence Area)	11-106
Exhibit A-11.45 Bayer Utility Plans.....	11-107
Exhibit A-11.46 Bayer Utility Photos.....	11-111
Exhibit A-11.47 North Kansas City-Lower (National Starch Area) Calculations....	11-113
Exhibit A-11.48 North Kansas City-Lower (National Starch Area) Alternative #1 Sump Layouts	11-125
Exhibit A-11.49 North Kansas City-Lower (National Starch Area) Alternative #2 Sump Layouts	11-128

Exhibit A-11.50 North Kansas City-Lower (National Starch Area) Preliminary Plan and Profile.....	11-131
Exhibit A-11.51 North Kansas City-Lower (National Starch Area) Utility Plan	11-133
Exhibit A-12.1 Significant Probability of Failure By Levee Unit.....	12-20
Exhibit A-12.2 Movement at a Floodwall Monolith Joint in the North Kansas City-Lower Unit.....	12-21
Exhibit A-13.1 Typical I-Wall Cross Section.....	13-9
Exhibit A-13.2 De-Loading at Station 60+40.....	13-11
Exhibit A-14.1 BPU Floodwall Probability of Failure	14-5
Exhibit A-14.2 Floodwall Modification	14-6
Exhibit A-14.3 Modified Floodwall Alternative	14-11
Exhibit A-14.4 Combined Modified and Replacement Floodwall Alternative	14-12
Exhibit A-14.5 Fairfax Drainage District Probabilities of Failure	14-13
Exhibit A-15.1 Turner Pump Station Features	15-7
Exhibit A-15.2 Argentine Unit - Turner Pump Station Analysis.....	15-29
Exhibit A-15.3 Argentine Pump Station Features	15-12
Exhibit A-15.4 Argentine Unit - Argentine Pump Station Analysis	15-200
Exhibit A-15.5 Strong Avenue Pump Station Features	15-16
Exhibit A-15.6 Argentine Unit - Strong Avenue Pump Station Analysis	15-208
Exhibit A-15.7 Additional Turner, Argentine, and Strong Avenue Pump Plant Calculations	15-220
Exhibit A-15.8 Argentine Station Replacement Schematic.....	15-20
Exhibit A-15.9 Argentine Unit - Bulk Mail Pump Station Analysis	15-233
Exhibit A-15.10 Argentine Unit - ConAgra Pump Station Plans	15-258

Exhibit A-15.11 Argentine Unit - ConAgra Pump Station Analysis.....	15-267
Exhibit A-15.12 Argentine Unit - ConAgra Pump Curve	15-275
Exhibit A-15.13 Typical Pump Station Discharge “Up and Over” Detail	15-278
Exhibit A-15.14 Argentine Unit - Santa Fe Pump Station Analysis.....	15-280
Exhibit A-18.1 Contractor Access for Argentine Raise.....	18-3
Exhibit A-18.2 Contractor Access for East Bottoms (Missouri and Blue Rivers Confluence Area).....	18-5
Exhibit A-18.3 Contractor Access for Fairfax-Jersey Creek BPU Floodwall	18-7
Exhibit A-18.4 Contractor Access for Fairfax-Jersey Creek (Jersey Creek Sheetpile Wall).....	18-9
Exhibit A-18.5 Contractor Access for North Kansas City-Lower (Harlem Area)	18-11
Exhibit A-18.6 Contractor Access for North Kansas City-Lower (National Starch Area)	18-13
Exhibit A-19.1 Timeline for Interim Feasibility Study Areas of Interest.....	19-2

ACRONYM LIST

A.S.B. – Armour-Swift-Burlington
BPU – Board of Public Utilities
CEMVS – St. Louis District
CENWK – Kansas City District
CH – Highly Plastic Clay
CID – Central Industrial District
CIP – Cast Iron Pipe
CL – Low to Moderate Plastic Clay
CMP – Corrugated Metal Pipe
COE – Corps of Engineers
COV – Coefficient of Variation
DIP – Ductile Iron Pipe
EC – Existing Conditions
EC-GD – Engineering Construction-Geotechnical Dam Safety
ECS – Existing Conditions Submission
ETL – Engineering Technical Letter
FDA - Flood Damage Assessment
FDD – Fairfax Drainage District
FOSM – First Order Second Moment
GDS – Geospatial Data Services
HEC – Hydrologic Engineering Center
HTRW – Hazardous, Toxic, and Radioactive Waste
KCD – Kansas City District
KCMO – Kansas City, Missouri
KCPL – Kansas City Power & Light
KCS – Kansas City Southern
KCT – Kansas City Terminal
KVDD – Kaw Valley Drainage District
ML - Silt
NAD – North American Datum
NED – National Economic Development
NKC – North Kansas City
NKCLD – North Kansas City Levee District
O&M – Operation and Maintenance
PM – Project Manager
PVC – Polyvinylchloride
R&U – Risk and Uncertainty
RCB – Reinforced Concrete Box
RCP – Reinforced Concrete Pipe
SM – Silty Gravel
SP – Poorly Graded Sand
U.E. – Upper End
USACE – United States Army Corps of Engineers
USCS – Unified Soil Classification System
UTM - Universal Transverse Mercator
VCP – Vitrified Clay Pipe
WWTP – Waste Water Treatment Plant